APPENDIX K
DIRECTED-ENERGY WEAPONS

This appendix introduces directed-energy weapons and gives an overview of how to defend against them. These new weapons are radically different in operation and effect from any other weapon in use. DEWs provide friendly forces target acquisition and engagement capabilities by detecting and locating enemy vehicles and soldiers rapidly, by providing early warning, and by degrading the enemy's fire control.

K-1. CHARACTERISTICS

Directed-energy weapons include lasers, microwave radiation emitters, and particle beam generators. These weapons produce casualties and damage equipment by depositing energy on the target. Conventional weapons rely upon the kinetic/chemical energy of a sizable projectile to defeat a target. DEWs depend upon subatomic particles or electro-magnetic waves impacting on the target at or near the speed of light.

a. For the foreseeable future, DEWs will be able to damage only soft targets, to include personnel or soft components of hard targets, such as the optics. Measures to preclude damage or destruction to currently fielded equipment and personnel from DEW engagement are limited, but by no means impossible or complicated.

b. In the future, equipment will be manufactured with built-in defenses against known DEWs, and older equipment may be refitted with protective devices. For the present, units can employ the measures discussed in this appendix to protect themselves from attack by DEWs.

K-2. LASERS

Lasers are DEWs that may be used against US forces in the near future. The presence of laser devices in the inventories of all major armies is increasing, and any laser-emitting device, such as a target designator or a range finder, can be employed as a weapon if it is aimed at a type of target it can damage.

a. The most probable target of laser weapons will be optical and electro-optical systems—specifically, fire control devices such as sights and the personnel behind the sights.

b. A laser beam entering a direct-view optical system, such as a telescope, has its power increased by the magnification of that system. Anyone looking through the system will suffer burns to the eye(s). The severity of the burns, the permanence of the damage, and the time required for the eye to heal itself depends on weather conditions, the intensity of the laser, the magnification of the optical device, the range to the laser source, the frequency of the laser, and the duration of the eye's exposure to the laser. Eye injury may range from temporary flash blinding and mild burns to total, permanent blindness. A soldier subjected to this type of injury may be incapacitated and unable to aim his weapon. It is anticipated that a laser weapon will fire at a target for a split second at most before laying on another target.

c. A laser beam entering a non-see-through electro-optical device, such as a night vision sight or thermal imagery device, will deposit its energy in the form of heat on the

sensor screens inside. If the heat is intense enough, it can burn out the screen, making the device useless. Some of the electrical circuits inside will also be burned out from the heat and from a sudden surge of electricity caused by the laser's energy.

d. Laser weapons may also be directed against individuals, but that is a very inefficient way to employ them. Effects on individuals are burns, with the eyes being most susceptible to injury. To be effective against soldier's eyes, the individual must be looking at the laser source. Because the eye is more sensitive to light at night, laser energy entering the eye during darkness will have a greater effect than it would during daylight. Some types of lasers will be hazardous to soldiers' eyes even though the laser cannot be seen.

e. Any uncovered glass surface (such as eyeglasses, vision blocks, or binoculars) has the potential to attract or alert an antielectro-optical weapon's target acquisition system.

K-3. DEFENSIVE AND PROTECTIVE MEASURES

Apply the following techniques to avoid detection by antielectro-optical weapon systems:

a. Use artillery, mortars, or direct fire weapons to suppress known or suspected antielectro-optical weapons locations. Smoke rounds are especially good for temporarily defeating laser devices.

b. When operating from static positions within line of sight of known or suspected enemy locations, minimize the exposure of glass surfaces in the direction of the enemy by positioning vehicles and weapons in covered or concealed positions.

c. When the mission requires maneuver and, consequently, the possible exposure of many glass surfaces, block the line of sight between friendly forces and known or suspected enemy locations with smoke or by planning routes to minimize exposure time.

d. Sound tactics will prevent friendly weapons locations from being pinpointed and subsequently targeted for attack by laser devices.

e. All devices that have external glass surfaces that are not in use should be covered or shielded until needed. Even vision blocks and headlights can alert antielectro-optical weapon target acquisition systems, so these must be included when taking protective measures. Tape, canvas, empty sandbags, or other materials can be used as covers.

f. Limit the number of personnel in observation positions to reduce the possibility of injuries. Use night vision goggles and thermal night sights when possible to protect these observers.

g. Gunners can use the AN/TAS-4 to scan for enemy laser devices. Blooming of the image is indicative of the presence of a laser. Gunners should be instructed to find and then avoid the threat laser device. Indirect fire should be used to neutralize the devices once they are located.

h. Tubular extensions over optical lenses will lessen their chances of being detected except from almost head on. These may be made from tubular ammunition packaging or other scrap materials.

i. Low energy antielectro-optical weapons will work only if they have line of sight to their target. They are just as effective at night as during the day; however, smoke, fog, snow, and dust will degrade their effectiveness. Another excellent countermeasure against some laser devices is to cover part of your optical lens with tape or some other type of cover (Figure K-1). Some degradation to viewing may exist; however, the benefit in reducing your vulnerability could be significant.

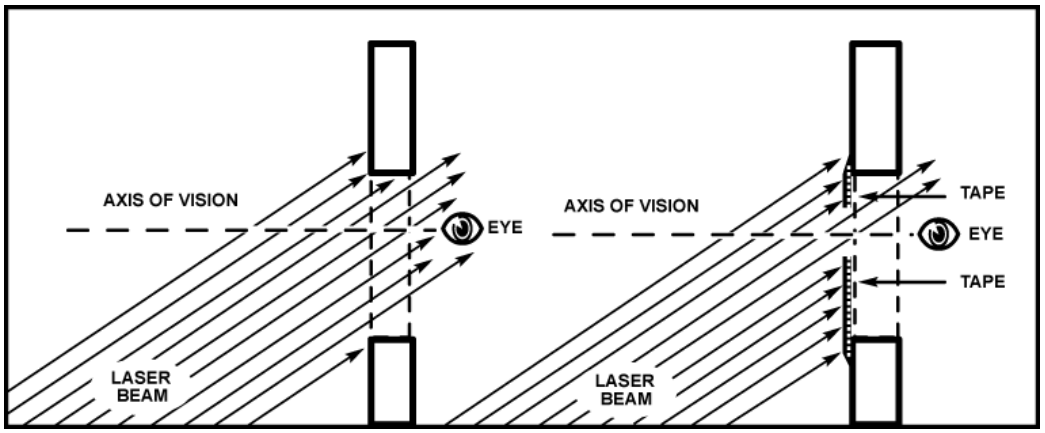

Figure K-1. Tape on vision blocks.

j. Soldiers should be aware of the potential hazard from laser devices currently in use in the US Army inventory. Devices most likely to be found in the vicinity of friendly soldiers are laser range finders.

k. Laser range finders are used on the M551A1, M60A3, and M1 tanks. They are also used a lot by the artillery. Artillery FISTs for airborne, ranger, and special forces units use the lightweight target designator; FISTs for mechanized, infantry, and air assault units use the ground-locating laser designator in either the ground-mounted or vehicle-mounted mode; and all FIST members use the GVS-5, binocular type, laser range finder. Some attack helicopters use a laser designator to direct the hellfire and copperhead systems. Additionally, artillery survey parties use laser devices for surveying in gun positions. Scout platoons are equipped with GVS-5 laser range finders.

l. Air Force and Navy aircraft may also carry laser target designators for aiming precision-guided munitions. The F-4, F-7, F-111, F-105, F-16, and A-6 aircraft may be equipped with these designators.

m. Operators of laser firing devices are given extensive training in their safe employment. The devices themselves cannot be activated without conscious, deliberate action on the part of the operator. While the possibility of an accident is extremely remote, it can happen. A victim might suddenly and unexpectedly move directly into the path of a laser beam and look directly at it, or a laser beam might reflect off a shiny surface and strike a victim in the eyes.

(1) To preclude such accidents, operators of laser firing devices must be kept constantly aware of friendly soldier locations, and they must positively identify targets before lasing them. Lasers should not be fired at reflective surfaces, and the warning "lasing" should be given before activating the laser.

(2) Conversely, commanders of soldiers operating in areas near friendly lasing must ensure that the commanders of laser-operating units are constantly aware of the friendly

soldier locations. Soldiers should be made aware of the presence of friendly lasers in their area and of the location of those lasers if possible. They should be warned not to look in the direction of laser-emitting devices unless specifically told it is safe to do so. Whenever possible, soldiers should wear laser protective goggles matched to the wave length of the friendly lasers. The ballistic and laser protective spectacles are currently issued through normal supply channels. BLPS are intended to be worn by individual soldiers day and night in both training and combat. When worn, BLPS protect the eyes from fragments and also reduce the risk of eye injury due to lasers.

K-4. DIRECTED ELECTROMAGNETIC PULSE

Electromagnetic pulse is electromagnetic radiation having frequencies ranging from 10 MHz to 4 GHz.

a. EMP may originate from nuclear detonations (nondirected EMP), from detonation of conventional explosives coupled with focusing electromechanical devices, and from electrically powered EMP generators on or above the ground.

b. EMP can severely damage or destroy sensitive electronic components, such as microchips, coils, and fuses, by overloading them with electrical current. Any equipment containing electronic components is subject to damage or destruction from EMP attack. FM radios are particularly susceptible to EMP damage. The amount of damage to equipment depends on its distance from the source of the pulse.

c. EMP may be projected into target areas from extremely long ranges. EMP can enter a targeted device through any opening and attack sensitive components inside even if the device is disconnected or turned off. For example, it may enter a radio set through the louvres over the cooling fans and destroy circuitry inside, making the radio useless. It may also enter through unshielded cables for antennas, power lines, and so forth.

d. An EMP attack lasts only for a split second and affects a tremendously large area. Protecting equipment from its attack is extremely difficult. The only totally reliable way to do it is to completely encase susceptible equipment in some type of heavy gauge metal shielding, or to completely surround it with special metal screening. Burying or covering with sandbags or other nonmetallic materials will not provide adequate protection. Terrain masking is ineffective because EMP follows the curve of the earth.

e. When operating from combat vehicles, sensitive equipment not absolutely needed for use at the moment should be disconnected and moved to the center of the vehicle. Smaller pieces of equipment should be placed in empty ammunition cans. Hatch covers should be kept closed unless someone is entering or exiting the vehicle. By doing this, only a minimum of equipment is susceptible to destruction, and the remainder is available for use after the attack.

f. Known or suspected locations of enemy ground-based EMP-generating weapons should be attacked by direct or indirect fire weapons within range.

K-5. MICROWAVE RADIATION EMITTERS

In the future, high-intensity microwaves may be used to severely damage or destroy miniaturized electronic components such as microchips by overloading them with electrical current. Microwaves enter targeted devices in the same manner as EMP. Long-term exposure to high intensity microwaves may also produce physical and psychological effects on humans, such as warmth, pain, erratic heartbeat and blood pressure, nose bleed, disorientation, headaches, fatigue, weakness, and dizziness.

a. Defense measures employed against EMP are also effective against microwaves. Additionally, terrain masking will provide some, but not complete protection. During maintenance operations, the operator must be careful not to damage or neutralize the EMP/HPM hardening techniques that may have been built into the equipment.

b. Ground-based microwave radiation emitters can be suppressed by direct and indirect fire.

K-6. PARTICLE BEAM WEAPONS

A particle beam is a directed flow of atomic or subatomic particles. These highly energetic particles, when concentrated into a beam that can interact with a target, can melt or fracture target material and generate X-rays around the point of impact. Should a particle beam weapon be developed sufficiently for use in ground combat, the same kind of defensive measures taken against any direct fire weapon will protect against its effects.

K-7. TRAINING

Commanders at all levels will have to mentally condition their subordinates to face the threat of DEWs. While DEWs appear at first glance to have devastating effects on men and equipment and effective defense against them seems nearly impossible, a basic understanding of what they are and how they work reveals them to be not nearly as bad as first supposed.

a. Laser, microwave, and EMP weapons damage their targets by attacking their soft electronic components. Their terminal effects are not as violent or destructive as those of conventional kinetic or chemical energy munitions. Even though they render their targets just as combat ineffective, the blast, fire, and fragmentation associated with conventional munitions is totally absent. The personal danger to the individual is significantly less from an attack by laser, microwave, or EMP weapons than it is in an attack by conventional munitions.

b. In the case of lasers, while the thought of eye injuries may be psychologically repulsive to the soldier, the extent of injury and subsequent recovery time for a laser injury is less than that for a gunshot wound. Also, permanent blindness in the affected eye is not a certainty, and it will occur in only a small percentage of incidents.

c. The advantage of particle beam weapons (if ever perfected) lies in their flat trajectory, long range, and large magazine capacity. Other than these advantages, they are similar to conventional tank cannons in employment and effect. Whether a vehicle is struck by a HEAT round, an APDS round, or a particle beam hardly matters; the effect on the vehicle and its occupants is essentially the same in all cases. At present, there is no known countermeasure against a particle beam weapon system.

d. Until such time as equipment is factory-hardened against DEWs, the defensive techniques discussed in this appendix will provide it with some protection from

directed-energy attack. Since DEWs that can injure people are line-of-sight systems, standard defensive techniques employed against any direct fire weapon will provide equal or better protection against personal injury from them because DEWs have no bursting radius.